



# 1.1 Number Toolkit

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## 1.1.1 Standard Form

### **Standard Form**

**Standard form** (sometimes called **scientific notation** or **standard index form**) gives us a way of writing very big and very small numbers using powers of 10.

#### Why use standard form?

- Some numbers are too big or too small to write easily or for your calculator to display at all
  - Imagine the number 50<sup>50</sup>, the answer would take 84 digits to write out
  - Try typing 50<sup>50</sup> into your calculator, you will see it displayed in **standard form**
- Writing very big or very small numbers in standard form allows us to:
  - Write them more neatly
  - Compare them more easily
  - Carry out calculations more easily
- Exam questions could ask for your answer to be written in standard form

#### How is standard form written?

- In standard form numbers are always written in the form  $a \times 10^k$  where a and k satisfy the following conditions:
  - 1 ≤ *a* < 10
    - So there is one non zero digit before the decimal point
  - $k \in \mathbb{Z}$ 
    - So *k* must be an integer
  - k > 0 for large numbers
    - How many times a is multiplied by 10
  - k < 0 for small numbers
    - How many times a is divided by 10

#### How are calculations carried out with standard form?

- Your GDC will display large and small numbers in standard form when it is in normal mode
  - Your GDC may display standard form as aEn
    - For example,  $2.1 \times 10^{-5}$  will be displayed as 2.1E-5
    - If so, be careful to rewrite the answer given in the correct form, you will not get marks for copying directly from your GDC
- Your GDC will be able to carry out calculations in standard form
  - If you put your GDC into scientific mode it will automatically convert numbers into standard form
    - Beware that your GDC may have more than one mode when in scientific mode



- This relates to the number of significant figures the answer will be displayed in
- Your GDC may add extra zeros to fill spaces if working with a high number of significant figures, you do not need to write these in your answer
- To add or subtract numbers written in the form  $a imes 10^k$  without your GDC you will need to write them in full form first
  - Alternatively you can use 'matching powers of 10', because if the powers of 10 are the same, then the 'number parts' at the start can just be added or subtracted normally
    - For example  $(6.3 \times 10^{14}) + (4.9 \times 10^{13}) = (6.3 \times 10^{14}) + (0.49 \times 10^{14}) = 6.79 \times 10^{14}$ or
      - $(7.93 \times 10^{-11}) (5.2 \times 10^{-12}) = (7.93 \times 10^{-11}) (0.52 \times 10^{-11}) = 7.41 \times 10^{-11}$
- To multiply or divide numbers written in the form  $a \times 10^k$  without your GDC you can either write them in full form first or use the laws of indices



### Worked example

Calculate the following, giving your answer in the form  $a \times 10^k$ , where  $1 \le a \le 10$  and  $k \in \mathbb{Z}$ .

i)  $3780 \times 200$ 

Using GDC: Choose scientific mode. Input directly into GDC as ordinary numbers. 3780 × 200 = 7.56 × 10<sup>5</sup> GDC will automatically give answer in standard form. Without GDC: Calculate the value: 3780 × 200 = 756000 Convert to standard form: 756000 = 7.56 × 10<sup>5</sup> 7.56 × 10<sup>5</sup>

ii)  $(7 \times 10^5) - (5 \times 10^4)$ 



Using GDC: Choose scientific mode. Input directly into GDC  $7 \times 10^{5} - 5 \times 10^{4} = 6.5 \times 10^{5}$ This may be displayed as 6.5E5 Without GDC: Convert to ordinary numbers:  $7 \times 10^{5} = 700\,000$   $5 \times 10^{4} = 500\,00$ Carry out the calculation:  $700\,000 - 50000 = 650000$ Convert to standard form:  $650000 = 6.5 \times 10^{5}$ 

6.5 × 10<sup>5</sup>

iii)  $(3.6 \times 10^{-3})(1.1 \times 10^{-5})$ 







### 1.1.2 Laws of Indices

### Laws of Indices

#### What are the laws of indices?

- Laws of indices (or index laws) allow you to simplify and manipulate expressions involving exponents
  - An exponent is a power that a number (called the base) is raised to
  - Laws of indices can be used when the numbers are written with the same base
- The index laws you need to know are:
  - $(XY)^m = X^m Y^m$

$$\left(\frac{x}{m}\right)^m = \frac{x^m}{m}$$

- $(y) y^m$
- $X^m \times X^n = X^{m+n}$
- $x^m \div x^n = x^{m-n}$
- $(x^m)^n = x^{mn}$
- $x^1 = x$
- $x^0 = 1$

$$\frac{1}{x^m} = x^{-m}$$

$$\frac{1}{n}$$

$$X^{n} = \sqrt[n]{X}$$

• 
$$X^n = \sqrt[n]{X^m}$$

• These laws are not in the formula booklet so you must remember them

#### How are laws of indices used?

 $n \Gamma$ 

- You will need to be able to carry out multiple calculations with the laws of indices
  - Take your time and apply each law individually
  - Work with numbers first and then with algebra
- Index laws only work with terms that have the same base, make sure you change the base of the term before using any of the index laws
  - Changing the base means rewriting the number as an exponent with the base you need
  - For example,  $9^4 = (3^2)^4 = 3^2 \times 4 = 3^8$
  - Using the above can them help with problems like  $9^4 \div 3^7 = 3^8 \div 3^7 = 3^1 = 3^1$







